Space Weather Technical Forecast

Issued on Saturday, 30 September 2023 at 01:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-flares throughout. Chance of G1 Minor Storm conditions on day 3 (02 Oct).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low activity with mainly low level C-class flares observed. The peak flare was a C7.5 event at 29/1824 UTC from an as yet unnumbered region currently at the northeast limb. There are ten sunspot regions on the disc. The most notable is AR3450 in the southeast, which has seen some small growth and has a moderately complex magnetic structure, although it remains a relatively small and inactive region. AR3449, approaching centre disc in the northern hemisphere has also seen the emergence of a small trailer spot and some small mixed polarity spots in the intermediate portion of the group. Again though, this region has been largely inactive. All other regions are magnetically simple at this time. No Earth-directed CMEs have been observed in the past 24hrs.

Solar Wind / Geomagnetic Activity: The near-Earth environment was indicative of residual weak CME effects from late 28 Sep, perhaps including some minor coronal hole fast wind influence. Solar winds were largely at slightly elevated levels, varying between 420-500km/s, but with a peak of 525km/s at 29/0945 UTC. Density was largely below average during the first half of the UTC day on 29 Sep, then largely average through the second half of 29 Sep. The interplanetary magnetic field (IMF), Bt, was mainly at weak levels, with occasional moderate levels reached (peak 8nT at 29/0945 UTC), mainly during the first half of the UTC day. The north-south component (Bz) was predominately negative (southward) and Moderate early in the period, with a minimum -8nT at 29/0912 UTC. Weak, mainly positive Bz has been observed since around 29/1000 UTC. Phi angle was largely positive (away from the Sun) but briefly became negative 29/0400-0900 UTC. Resultant geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels. GOES16 high energy (greater than 2MeV) electron flux was initially Moderate, but dropped out early in the UTC day on 29 Sep, due to a weak CME which arrived late on 28 Sep. Flux recovered to Moderate and then High through the second half of the UTC day on 29 Sep, reaching at peak of 3090 pfu at 29/1455 UTC. Associated 24-hour fluence remained below the Active (1e8 integrated pfu) threshold, on a slowly declining, then steadily rising trend, just below the Active threshold by the end of the UTC day. The observation at 30/0000 UTC was 8.88e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Activity is expected to remain at Low to Moderate levels, with a chance of isolated M-class flares.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. Current slightly elevated solar winds may involve some combination of residual CME effects from 28 Sep and also connection to a northern hemisphere coronal hole. Winds may vary, somewhat erratically between slightly elevated and background levels in the coming days, until the main coronal hole fast wind enhancement (CH54/+) takes place. This is anticipated to occur on day 3 (02 Oct).

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Speeds are then expected to increase to slightly elevated to elevated levels by the end of day 4 (03 Oct).

Mainly Quiet to Unsettled geomagnetic activity is expected until the main enhancement occurs, most likely day 3 (02 Oct). Activity is then expected to increase to be Unsettled to Active with a chance of G1 Minor Storms, before reducing back to mainly Quiet to Unsettled levels on day 4 (03 Oct).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at Background. High energy electron flux (greater than 2MeV) is expected to be mainly Moderate, with diurnal peaks of High at first. Likely reducing to background to Moderate from day 3 (02 Oct) onwards. The fluence is likely to rise just above Active levels on day 1 (30 Sep), but with a reducing day-on-day probability of exceeding the threshold.

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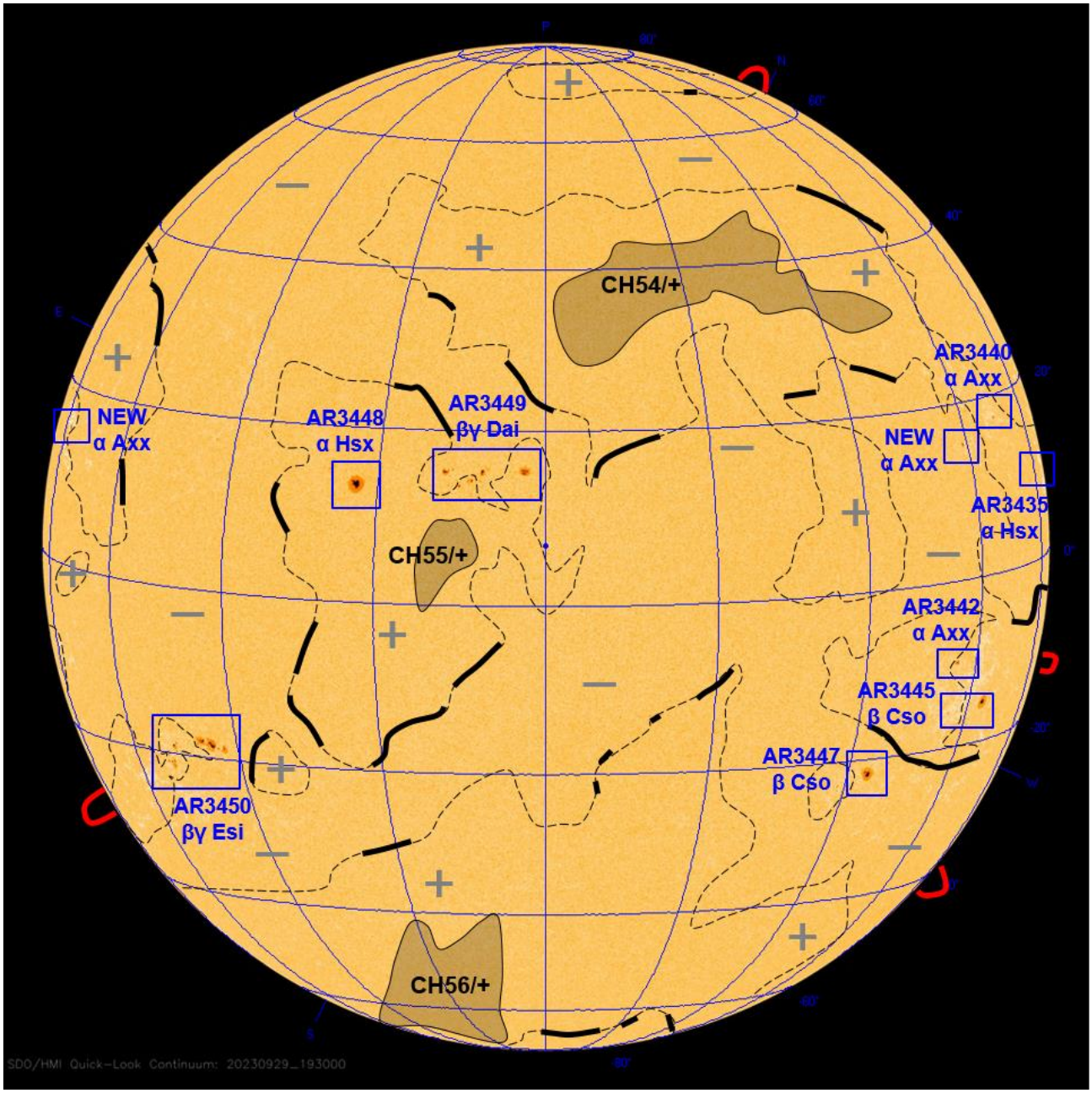
Figure 1. Solar Analysis Valid 29/1930 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no Earth-directed CMEs.

Residual CME effects from the 28 Sep arrival have largely eased, although speeds still remain at slightly elevated levels. This is perhaps related to a connection to CH54/+ in the northern hemisphere. It is a broad feature in terms of longitudinal extent, but given its mid-high latitude on the solar disc may result in an erratic connection with Earth until later in the period (probably day 3 - 02 Oct onwards), due to a southeast extending lobe currently near centre disc. Considering its positive polarity, this is more favoured for connection at this time of year, bringing a chance of solar winds increasing to around 500 km/s and some enhancement geomagnetic activity. This is broadly inline with the current MOSWOC enlil forecast.

Mainly Quiet to Unsettled geomagnetic activity is expected until the main enhancement occurs, most likely day 3 (02 Oct). Activity is then expected to increase to be Unsettled to Active with a chance of G1 Minor Storms, before reducing back to mainly Quiet to Unsettled levels on day 4 (03 Oct).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	5	30	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections - Nil

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Radio Blackouts - X-Ray Flares:

Low to Moderate activity is expected with a chance of isolated M-flares.

Of the ten sunspot regions currently on the disc, AR3450 in the southeast remains the most complex, with some small, weak negative spots in close proximity to its positive trailer, and some slow spreading of the main lead and trailer spots. The region includes a beta-gamma magnetic structure, however, only low C-flares have been observed. AR3449, approaching the northern centre disc, is perhaps the next most complex with the ongoing proliferation of weak mixed polarity spots in the intermediate portion of the group and a beta-gamma structure. The other pre-existing sunspots remain stable or slowly declining. A new small Alpha spot has emerged to the southeast of AR3440, meanwhile another region has emerged in the far northeast. Tentatively, the region is designated an Alpha/Axx group, but a number of recent low-level C-class flare may indicate that the group is more magnetically complex than this. As the region rotates into clearer view, away from the eastern horizon, it may unveil more spots that are not yet apparent.

Some magnetic looping is evident in imagery e.g. SDO/aia-171 on the northeast limb, perhaps associated with ex-3423. This was the expected source of the C7.5 flare at 29/1824 UTC and suggests that a further sunspot region is likely to rotate onto the disc during the next 24 hours.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	35	35	35	35
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 2: 24-hour GOES 16 and 18 X-ray flux

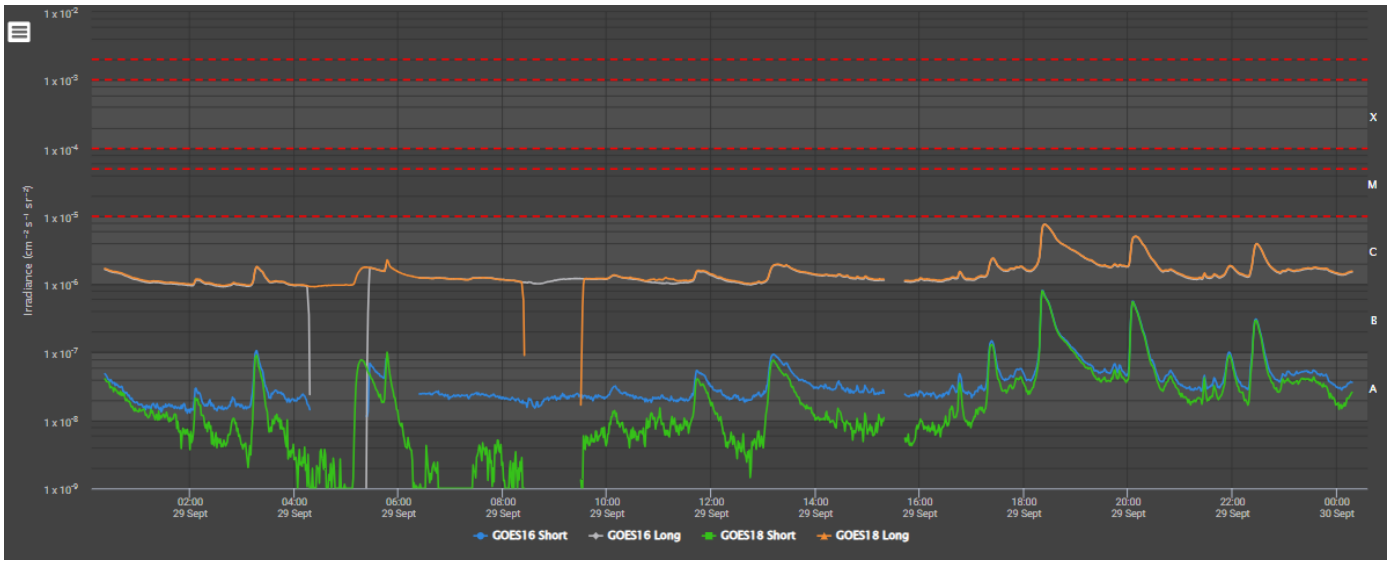

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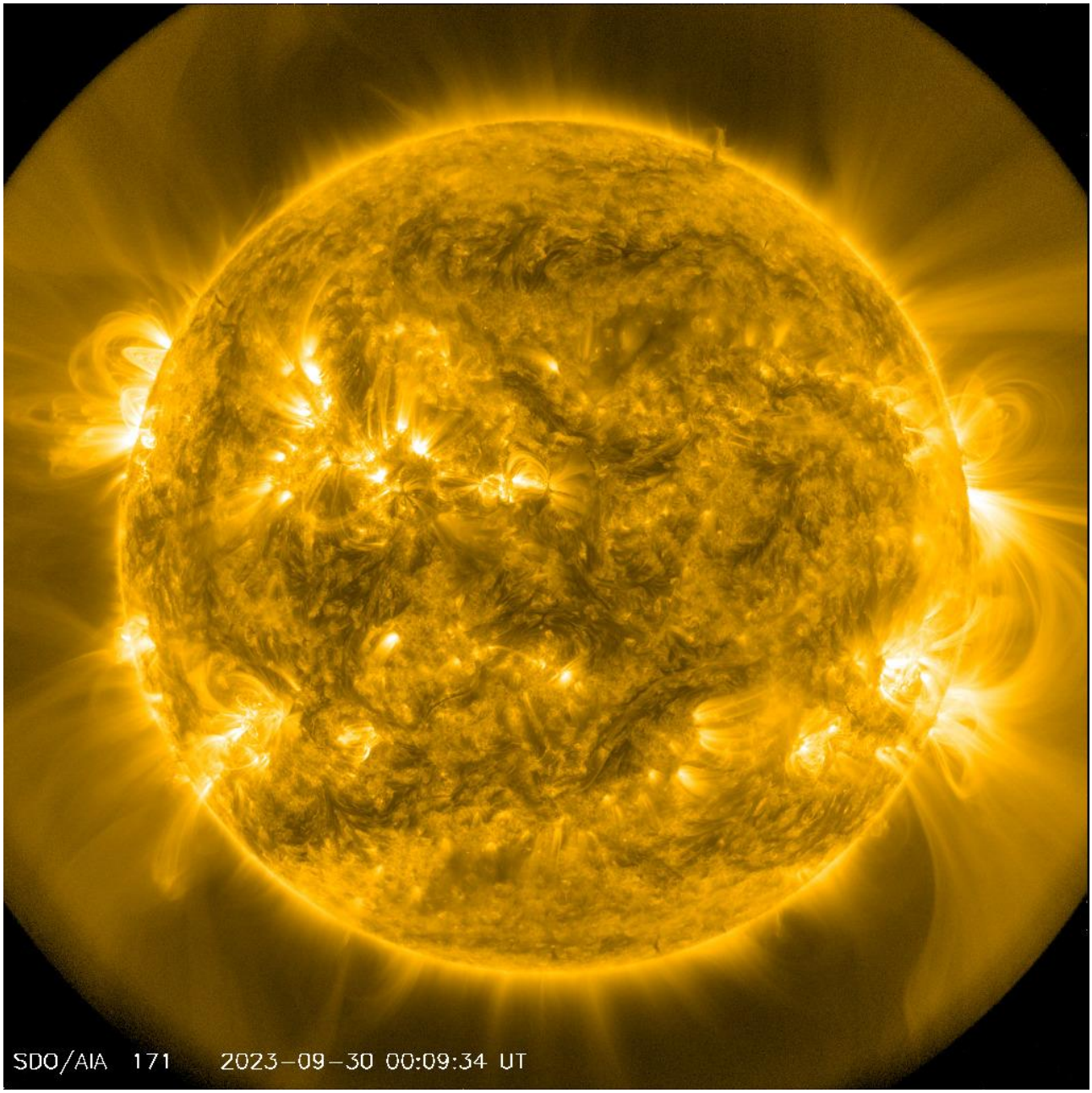
Figure 3: SDO/AIA 171 imagery at 30/0009 UTC. Note magnetic looping associated with region responsible for C7.5 flare at the northeast limb.



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is expected to persist at background levels, with the current sunspots on the disc considered very unlikely to produce proton events.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	2	2	2	2
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) observed by GOES16 was initially Moderate on 29 Sep, but dropped out early in the UTC day due to a weak CME which arrived late on 28 Sep. Flux recovered to Moderate and then High through the second half of the UTC day on 29 Sep. A general downtrend in electron flux is expected in the coming days, becoming generally Moderate, but still occasionally high during diurnal maximum. These values are expected to persist until day 3 (02 Oct) when a further drop out is likely from the onset of any fast winds from CH54/+.

The fluence is likely to rise just above Active levels on day 1 (30 Sep), but with a reducing day-on-day probability of exceeding the threshold. This is broadly supported by REFM, which currently has a declining trend.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	No	70	40	10	1
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

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Figure 4: GOES 16 >2MeV Electron flux (above) and latest MOSWOC REFM with recurrence forecast (below). REFM forecast is currently offering good guidance.

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